SRM UNIVERSITY AP
Andhra Pradesh

# SCHOOL OF ENGINEERING AND SCIENCES

# B.Sc. (Hons) Physics

# 2022-26 Batch

## B. Sc. (Hons) Physics

| Semester-3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Category** | **Sub-Category** | **Course Title** | **L** | **T/D** | **P/Pr** | **Credits** | **Learning Hours** |
| AEC | School AEC | Problem Solving Skills | 1 | 0 | 1 | 2 | 60 |
| VAC | School VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* | 0 |
| VAC | School VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2* | 0 |
| SEC | Department/School SEC | Digital Literacy | 1 | 0 | 1 | 2 | 60 |
| CC | Core | Introduction to Optics | 3 | 0 | 1 | 4 | 120 |
| CC | Core | Advanced Mathematical Physics | 3 | 1 | 0 | 4 | 120 |
| CC | Core | Quantum Mechanics | 3 | 1 | 0 | 4 | 120 |
| OE/Minor | MC/OE | | 3 | 0 | 0 | 3 | 90 |
| | | | | | **Semester Total** | **19** | **570** |
| **Semester-4** | | | | | | | |
| **Category** | **Sub-Category** | **Course Title** | **L** | **T/D** | **P/Pr** | **Credits** | **Learning Hours** |
| AEC | School AEC | Creativity and Critical thinking Skills | 1 | 0 | 1 | 2 | 60 |
| VAC | School VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* | 0 |
| VAC | School VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2* | 0 |
| SEC | Department/ School SEC | Mathematical Modelling of Physical Data | 2 | 0 | 0 | 2 | 60 |
| CC | Core | Electrostatics and Electric Current | 3 | 0 | 1 | 4 | 120 |
| CC | Core | Heat and Thermodynamics | 3 | 1 | 0 | 4 | 120 |
| CC | Core | Electrodynamics | 3 | 1 | 0 | 4 | 120 |
| CC | Core | Analog and Digital Electronics | 3 | 0 | 1 | 4 | 120 |
| OE/Minor | MC/OE | | 3 | 0 | 0 | 3 | 90 |
| | | | | | **Semester Total** | **23** | **690** |
| **Semester-5** | | | | | | | |

| Category | Sub-Category | Course Title | L | T/D | P/Pr | Credits | Learning Hours |
|---|---|---|---|---|---|---|---|
| VAC | School VAC | Co-Curricular Activities | 0 | 0 | 2 | 2* | 0 |
| VAC | School VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2* | 0 |
| SEC | SEC Elective | Career Skills 1 | 2 | 0 | 1 | 3 | 90 |
| CC | Core | Solid State Physics | 3 | 0 | 1 | 4 | 120 |
| CC | Core | Statistical Physics | 3 | 0 | 1 | 4 | 120 |
| CC | Core | Atomic and Molecular Physics | 3 | 1 | 0 | 4 | 120 |
| CC | Core | Special Theory of Relativity | 3 | 1 | 0 | 4 | 120 |
| OE/Minor | MC/OE | Minor 3/Open Elective 3 | 3 | 0 | 0 | 3 | 90 |
| **Semester Total** | | | | | | **22** | **660** |

**Semester-6**

| Category | Sub-Category | Course Title | L | T/D | P/Pr | Credits | Learning Hours |
|---|---|---|---|---|---|---|---|
| VAC | School VAC | Co-Curricular Activities | 0 | 0 | 2 | 2 | 60 |
| VAC | School VAC | Community Service and Social Responsibility | 1 | 0 | 1 | 2 | 60 |
| SEC | SEC Elective | Career Skills 2 | 2 | 0 | 1 | 3 | 90 |
| CC | Core | Nuclear and Particle Physics | 3 | 1 | 0 | 4 | 120 |
| CC | Core | Mentored Project | 0 | 0 | 4 | 4 | 120 |
| CC | Department | Core Elective 1 | 3 | 1 | 0 | 4 | 120 |
| CC | Department | Core Elective 2 | 3 | 1 | 0 | 4 | 120 |
| OE/Minor | MC/OE | Minor 4/Open Elective 4 | 3 | 0 | 0 | 3 | 90 |
| **Semester Total** | | | | | | **26** | **780** |

| Semester-7 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Category** | **Sub-Category** | **Course Title** | **L** | **T/D** | **P/Pr** | **Credits** | **Learning Hours** |
| CC | CE/SE | Core Elective 3 | 3 | 1 | 0 | 4 | 120 |
| CC | CE/SE | Core Elective 4 | 3 | 1 | 0 | 4 | 120 |
| CC | CE/SE | Core Elective 5 | 3 | 1 | 0 | 4 | 120 |
| RDIP | Internship /Research / Thesis | Project I | 0 | 0 | 5 | 5 | 150 |
| OE/Minor | MC/OE | Minor 5/Open Elective 5 | 3 | 0 | 0 | 3 | 90 |
| | | | | | **Semester Total** | **20** | **600** |
| **Semester-8** | | | | | | | |
| **Category** | **Sub-Category** | **Course Title** | **L** | **T/D** | **P/Pr** | **Credits** | **Learning Hours** |
| RDIP | Internship /Research / Thesis | Research Project | 0 | 0 | 12 | 12 | 360 |
| | | | | | **Semester Total** | **12** | **360** |

| **Core Electives**: |
|---|
| 1. Introduction to astrophysics |
| 2. Introduction to soft matter physics |
| 3. Numerical methods and simulation techniques |
| 4. Electronic materials & device physics |
| 5. Device characterization and instrumentation |
| 6. Optical information processing |
| 7. Introduction to LabVIEW and ZView |
| 8. Artificial Intelligence in Complex Systems |
| 9. Physics of financial markets |
| 10. Game theory: Classical and Quantum |
| 11. Battery Materials |
| 12. Battery Design & Testing |
| 13. Beyond Li ion batteries |
| 14. Quantum algorithms and complexity |
| 15. Quantum Computation and error correction |
| 16. Quantum Optimization |

| **Minor in Quantum Computation** |
|---|
| 1. Foundations of Mathematical Physics |
| 2. Quantum Mechanics |
| 3. Quantum algorithms and complexity |
| 4. Quantum Computation and error correction |
| 5. Quantum Optimization |

| **Minor in Device Physics** |
|---|
| 1. Solid state physics |
| 2. Electronic materials & smart devices |
| 3. Thin film deposition and device fabrication |
| 4. Device characterization and instrumentation |
| 5. Solid state ionic devices |
| 6. Simulation and modelling in solid state devices |

| **Open Elective** |
|---|
| 1. Introduction to Astrophysics |
| 2. Quantum Computation |
| 3. Electronic Materials and Smart Devices |
| 4. Quantum Optimization |
| 5. Solid State Ionics devices |
| 6. Optical information processing |
| 7. Thin film deposition and device fabrication |

# Appendix-I

# Syllabus of III & IV Semesters

**Semester III**

**Problem Solving Skills**

**Digital Literacy**

Structure of a computer; Basics of Operating System; Application software: Office Automation – Creation and usage of word documents, creating Presentations, using spread sheets

Usage of Google drive, docs, sheets and slides; Online resources: Navigating a website, Search Engines, Bookmarks, Online fraud and scams, Internet Privacy, Creating Blogs, Managing social media, DigiLocker; Best practices for the usage of ICT methods; Video conferencing, best apps for online notetaking; Managing digital identity and reputation, reporting online cheating cases; Cyber security: Discussion of issues such as cyberbullying, phishing scams, and avoiding or detecting malware.

**Waves and Oscillations**

The course addresses different types of oscillations and their various applications. transverse and longitudinal waves and their propagation. Waves, propagation, and superposition of waves are discussed to understand various phenomena e.g., Doppler effect, standing wave, interference etc.

**Advanced Mathematical Physics**

The course will discuss the advanced methods used in different branches of physics. It covers topics such as sequences and series, special functions like Legendre's function, Bessel's functions. Then the concept of Fourier analysis and Fourier transforms along with the physical applications will be discussed. We also learn partial differential equations and their solution using Fourier concepts. Moreover, the complex analysis and tensors will be covered which will be beneficial in future physics courses.

**Quantum Mechanics**

Detection of thermal radiation, Prevost's theory, Emissive power of different bodies, Absorptive power of different bodies, Black body radiation, Kirchhoff's law, Pressure of radiation, Stefan-Boltzmann law and its experimental verification, Nernst heat theorem, Planck's Radiation Law, Photoelectric Effect, Numerical of Photoelectric effect, Compton Effect, Wave particle duality, Matter waves, De Broglie hypothesis, Concept of wave packet, The principle of Superposition, Davisson and Germer experiment, Phase velocity, group velocity and relation between them, Heisenberg's uncertainty principle with thought, Experiment, Different forms of uncertainty, Electron diffraction, experiment Wave function and its physical interpretation, Boundary Condition of Wavefunction, Definition of an operator in Quantum mechanics Linear vector space & Hilbert Space, Hermitian Operator,

Linear Operator, Position, Momentum and Total energy operator, Commutator brackets-Simultaneous Eigen functions, Commutator algebra, Commutation of position and momentum, Probability Amplitude, Probability Density, Probability, Stationary States, Expectation value, Eigen function and Eigen values, Ehrenfest's theorem, Schrodinger time dependent Schrodinger time independent equation, Probability Current Density, Stationary States and Bound States, Free particle, Particle in infinitely deep potential well, (one – dimensional), Particle in a three-dimensional rigid box, Step potential, potential barrier (Qualitative discussion), Barrier penetration and tunneling effect, Harmonic oscillator (one-dimension), Schrodinger equation in spherical polar coordinate, Hydrogen atom: Qualitative discussion on the radial and angular parts of the bound state energy, Quantum numbers n, l, ml, ms – Degeneracy, Angular Momentum.

**Semester IV**

**Creativity and Critical thinking Skills**

**Mathematical Modeling of Physical Data**

Probability and distribution; mean variance and standard deviations; different distribution functions; central limit theorem; Error analysis Graphical and numerical analysis using python: Application of above lecture parts including Error Analysis- precision and accuracy; types of error (random, systematic); significant digits, round-off; propagation of errors; weighted average; least-square fitting; chi-squared test. Use python as a tool to solve a numerical problem-based project. Example: trend and analysis of climate change data; stock market stylized facts etc.). prepared using LaTeX.

**Electrostatics and Electric Current**

Vector calculus & co-ordinate systems, Line, surface, and volume integral. Coulomb's law & Electrostatic Force; Superposition principle, Electric field due to point charge & group of charges, Electric field due to continuous charge distribution, Concept of electric flux – introduction to Gauss Law, Electrostatic potential – inter-relation with ES field Electro-static energy of the system of point charges and charge distribution – worked examples, ES field due infinite wire and infinite sheet of charge, ES field due to conducting and insulating sphere, ES field due to conducting and insulating cylinder, Worked examples of boundary value problems, Conducting sphere in a uniform field Review of boundary value problems, Electric potential due to dipole, Electric field intensity due to dipole Torque on electric dipole in external electric field, Effect of external electric field on non-polar molecules induced dipole moment – Image charge formation, Dipole-dipole interaction in a plane, out of plane and positioned at certain angle, Dipoles in Uniform and non-uniform electric field, Potential near an Arbitrary Charge Distribution, Quadrupole Moment, Two Simple Quadrupoles, Qualitative discussion on Octuplet Moment Polar and non-polar molecules, Atomic polarizability and related problems, Electric polarization of dielectric material Electric polarization vector, Strength of dielectric, material and Dielectric breakdown, Electric displacement and Gauss law in dielectric, Relation between three electric vectors (E, D and P) Plane Parallel Capacitor, Capacitor filled with dielectric, Coaxial Cylindrical Capacitor, Concentric, Spherical Capacitor, Capacitors in Parallel, Capacitors in Series, Charging and discharging of Capacitor using High Resistance. Revisiting Resistors: Series and Parallel resistance. Color code of resistors. Kirchhoff's Law's. Introduction to inductors: self and mutual inductance. Transient current in DC Circuits: LR, LC, LCR circuits. Alternating currents: basic ideas of generation, mean and RMS values Behavior of resistor (R), capacitor

(C) and inductor (L) in AC circuits: Introduction of Phasor Diagram Current and Voltage in LR & CR circuits in AC using phasor diagram: Impedance triangle. LCR circuit, series and parallel resonance, bandwidth, and Q-value. Losses in A. C. circuits: the skin effect & eddy current. Delta & Star Network of Impedance. Working of a Transistor: Step-up and Step-down transformer. Properties of ideal transformer. Impedance matching of a transformer.

**Heat and Thermodynamics**

Ideal Gas, Ideal Gas Equation Assumptions of Kinetic Theory of gases, Pressure of an ideal gas (no derivation) Kinetic interpretation of Temperature, Ideal Gas equation Degree of freedom, Law of equipartition of energy and its applications for specific heats of gases Maxwell distribution of gas molecules speed (derivation) Experimental verification of Maxwell's Law of speed distribution Most probable speed, average and root mean square (r.m.s.) speed, Mean free path Real gases, Andrew's experiment, Vander Waal's equation of ideal gases, interpretation of a and b parameters Thermodynamic state of a system, Thermal Equilibrium Zeroth law of Thermodynamics Internal Energy of System-Concept of heat and temperature First law of Thermodynamics Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric Adiabatic relations of system for perfect gas Work done during Isothermal and Adiabatic changes Reversible and Irreversible processes in thermodynamics Second Law of Thermodynamics: Entropy Conversion of Heat into Work and its converse Carnot's Cycle and Carnot's Heat Engine and its efficiency Second law of Thermodynamics: Statements, Carnot Theorem Entropy, Principle of Increase in Entropy Generalized form of the First and Second laws Entropy changes for an Ideal Gas Entropy changes for van der Waals' gas Otto cycle, Diesel cycle and its comparison, efficiencies The Carnot Refrigerator, Air conditioning: principle and its applications Maxwell's thermodynamics relations How to remember the maxwell's relations Significance of Maxwell's relations Thermodynamics relations with heat capacities Three TdS equations Helmholtz Free energy Gibbs Free energy Enthalpy Clausius-Clapeyron's equations Thermoelectric effect, Seebeck effect  Peltier effect Thomson effect Thermoelectric generators, Applications of Thermoelectric generators and its applications Thermocouples, Temperature measurement, Thermoelectric materials.

**Electrodynamics**

Concept of magnetic field intensity (B) and flux, Definition, and properties of magnetic field, Definition of B and H, Calculation of divergence and curl of B with boundary conditions, Lorentz Force law, motion of charged particles in electric and magnetic field, Cyclotron frequency, Biot – Savart's law, Illustration with long straight conductor, current carrying circular loop on the axis Calculation of field on the Axis and in plane of a circular current-

carrying Coil, Helmholtz Coils Magnetic moment of a current carrying loop The Permeability of Free Space, Ampère's Law – worked examples, Force Between Two Current-carrying Wires, Problems based on magnetic field and Magnetostatics, Magnetic Materials - An Overview, Magnetic moment, Bohr magneton, Magnetization (M), Magnetic Intensity (H) and magnetic induction (B) – their mathematical relations, Magnetization and Susceptibility and magnetic permeability of magnetic materials Magnetic field of magnetized objects and bound currents Diamagnetic, paramagnetic, and ferromagnetic Explanation of Diamagnetic, paramagnetic. Ferromagnetic with the help of susceptibility and permeability Hysteresis and B-H Loops Problems on magnetism and its properties Time varying fields: Faradays law of induction, worked examples Mutual inductance, coupled circuits and coefficient of coupling Leakage inductance, impedance matching Transformer circuit Reflected impedance transformation, equivalent circuit of a transformer Lenz's Law, Worked examples Ballistic Galvanometer and the Measurement of Magnetic Field AC Generator, AC Power,0 Linear Motors Generators, Rotary Motors Generalization of Amperes' law Problems on Amperes' law – worked examples Maxwell's equation Maxwell's equation - Differential form Maxwell's equation -Integral form Problems on Maxwell's equation, Magnetic Vector potentials Retarded potential Problems on Magnetic Potentials Wave equation and plane waves in free space Poynting theorem Polarizations of plane wave Plane monochromatic waves in conducting media. Reflection from a conducting plane Skin effect, Absorption, and scattering Absorption and scattering of electromagnetic waves Anomalous dispersion Problems on electromagnetic waves – worked examples.

**Analog and Digital Electronics**